

Ontrack® Data Recovery

October 1, 2008

Space Shuttle Columbia Hard Drive: How NASA Data was Recovered After Crash

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Agenda

- Timeline of Events
- Recovery of data details
- Hard drive comparison
- Data recovery highlights
- Technology advances but data recovery still needed
- Questions
- KrollOntrack company information/Services & Software defined

Timeline of Events

- February 1, 2003
 - Space shuttle Columbia disaster
- September 26, 2003
 - Ontrack Data Recovery receives 3 drives recovered from debris
- September 29, 2003
 - Ontrack completes recovery of one of the disks
- April 17, 2008
 - Physical Review E publishes results of CVX-2 experiment

Recovery of Data Details

- Johnson Space Center engineers find the remains of 3 hard drives in the Columbia debris that was being laid out in the hanger at Kennedy Space Center.
- Glenn Research Center sent drives to Ontrack to see if anything was recoverable.
- Two of the three drives were found to have hard drive platters that were warped from the heat that had reached the Curie point because tests on the platters showed no sign of magnetic data.

Recovery of Data Details

- The third disk was covered with a sheet of metal on top of the hard drive.



Recovery of Data Details

- Engineers worked to cut away protective top cover to get access to hard disk assembly.



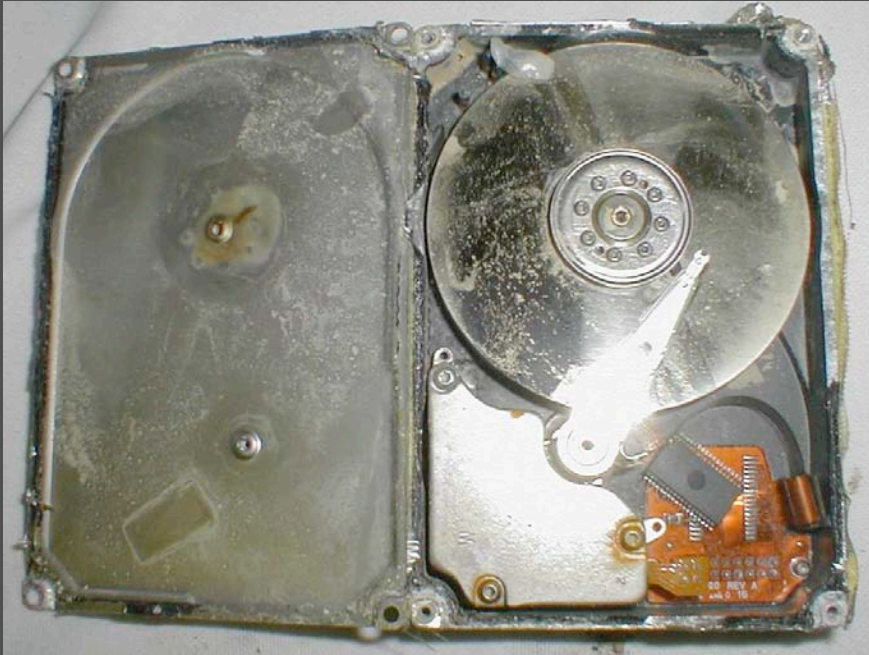
Recovery of Data Details

- Engineers then removed the hard drive's PCB.



Recovery of Data Details

- Engineers then opened the top cover of the hard disk.



Recovery of Data Details

- Engineers had to remove melted plastic from media and corroded, melted head assembly to remove each hard drive platter.



Recovery of Data Details

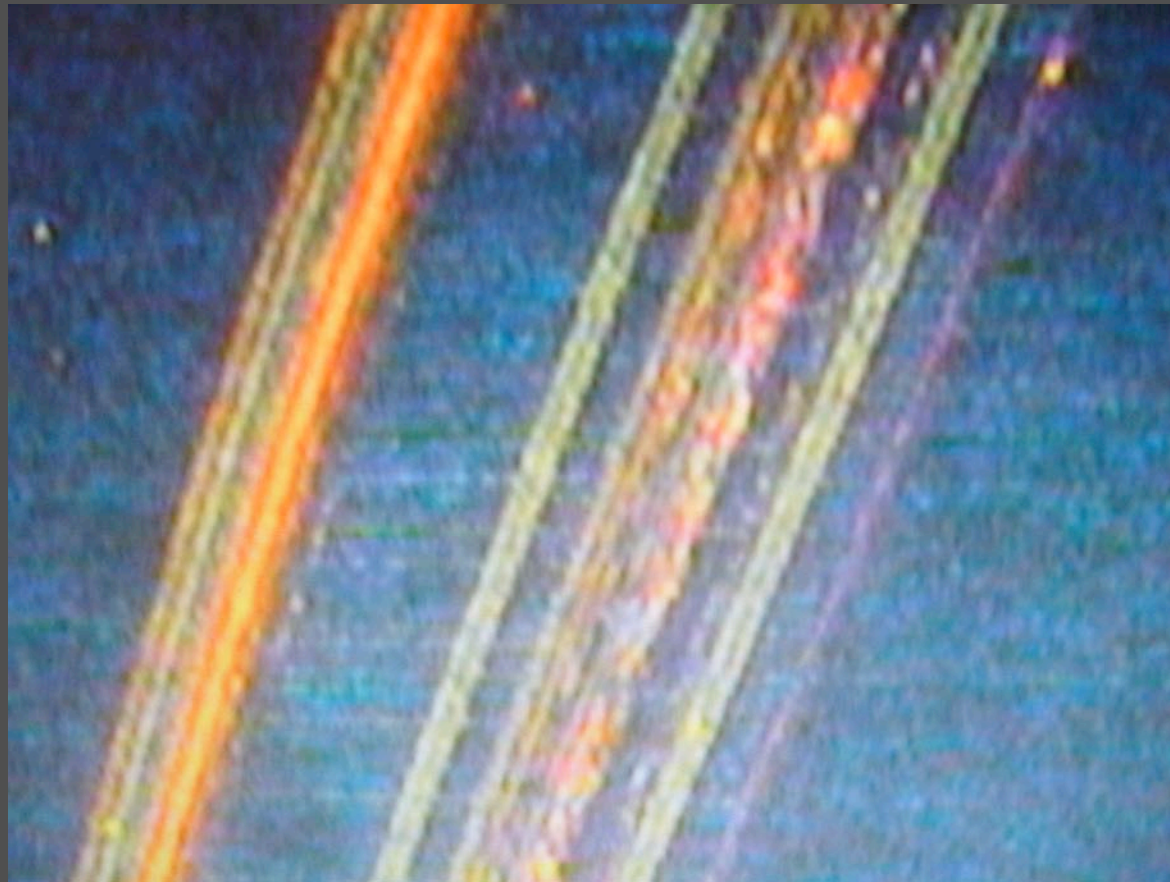
- Engineers were able to carefully remove each hard drive platter in order to place it in a new enclosure with replacement PCB controller.
- The rest of the components were luckily replaceable with only minor adjustments necessary. Components in modern drives are not as compatible – much more adjustment needs to take place.
- Kroll Ontrack used custom software for data transfer that includes sophisticated error handling, ECC calculation, etc. We use our extensive knowledge of Operating Systems to target just the areas where data resides, which allows us to avoid damaged areas unless absolutely necessary. Modern OS's tend to scatter the data, but this drive used DOS FAT16, which kept the data contiguous.

Recovery of Data Details

- Ontrack was able to read 99% of the data contained on this one disk within two days of receiving the drives.
- We produced detailed file report of recoverable data so Glenn engineers could determine if they needed the data we had recovered.
- Contributing factors to Ontrack's eventual success-
 - Protective cover on top of hard drive assembly appeared to shield excessive heat from penetrating hard drive assembly and warping platters.
 - Hard disk was not spinning when incident occurred, so damage on the surface of the media was limited to minor "dings" and not full head crashes.

Recovery of Data Details

- Data and encoding tracks were larger which allowed for greater fault tolerance



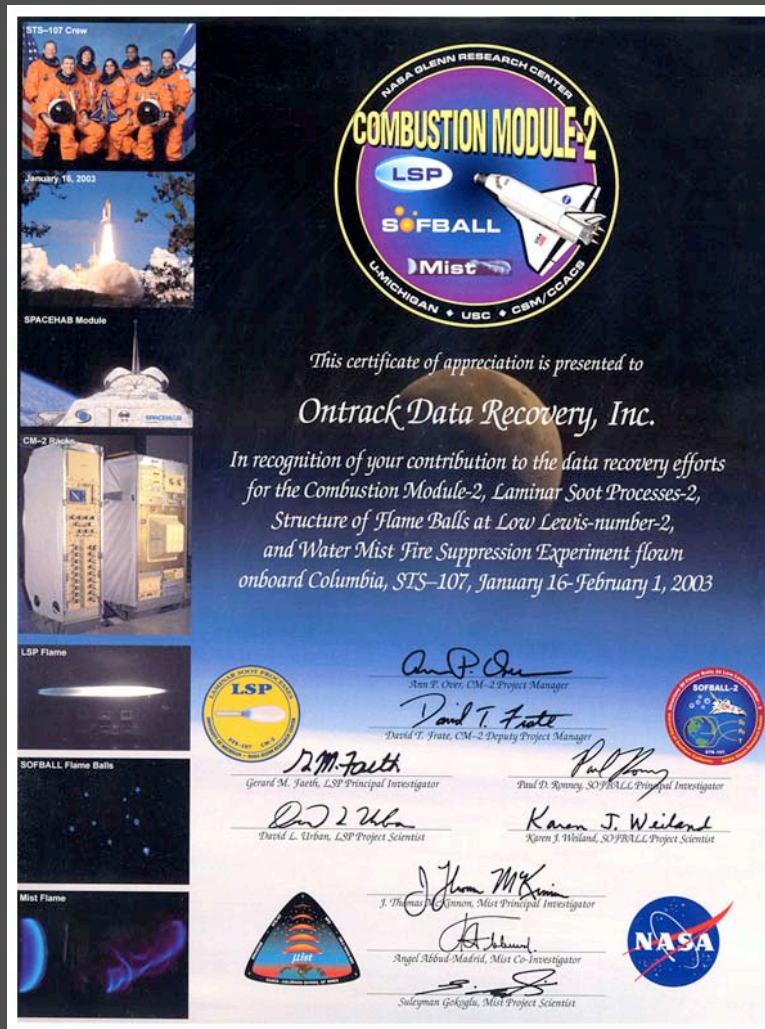
Hard Drive Comparison

Hard drives 1993 vs.
2008

<u>Hard drive component</u>	<u>Seagate 1993</u>	<u>Seagate 2008</u>
Read/write heads	Inductive - reading + writing	Inductive - reading
		GMR (Giant Magneto-resistive) - writing
Platters	Aluminum	Glass
Motor	4200 rpm	7200 rpm
	Ball bearings	Fluid bearings
PCB	20 main ICs	4 main ICs
Cache size		4MB
Interface	PATA	SATA
Recording type	Longitudinal	Perpendicular
Capacity	341 MB	500 GB

Recovery of Data Details

Certificate of appreciation presented to us from Glenn facility



Data Recovery Highlights

- 1991-Recovery of data in Kuwait after original Iraqi invasion
- 1992-Stoned and Michelangelo virus outbreaks
- 1997-Patented Remote Data Recovery
- 1998-Nagano Olympics
- 1999-Y2K fears alleviated
- 2005-Hurricane Katrina-over 900 unique recoveries performed
- 2006-Salie family DVD recovery
- 2008-Customized recoveries for proprietary file systems
- 2008-VMware and Oracle

Technology Advances

- All of these technologies were created to alleviate need for data recovery, but yet the number of data recoveries Ontrack performs each year continues to grow.
 - Traditional tape backup
 - Virtual Tape Libraries
 - Online backup
 - RAID 0, 1, 2, 3, 4, 5, 6, 10, 50...
 - Virtualization



Questions?

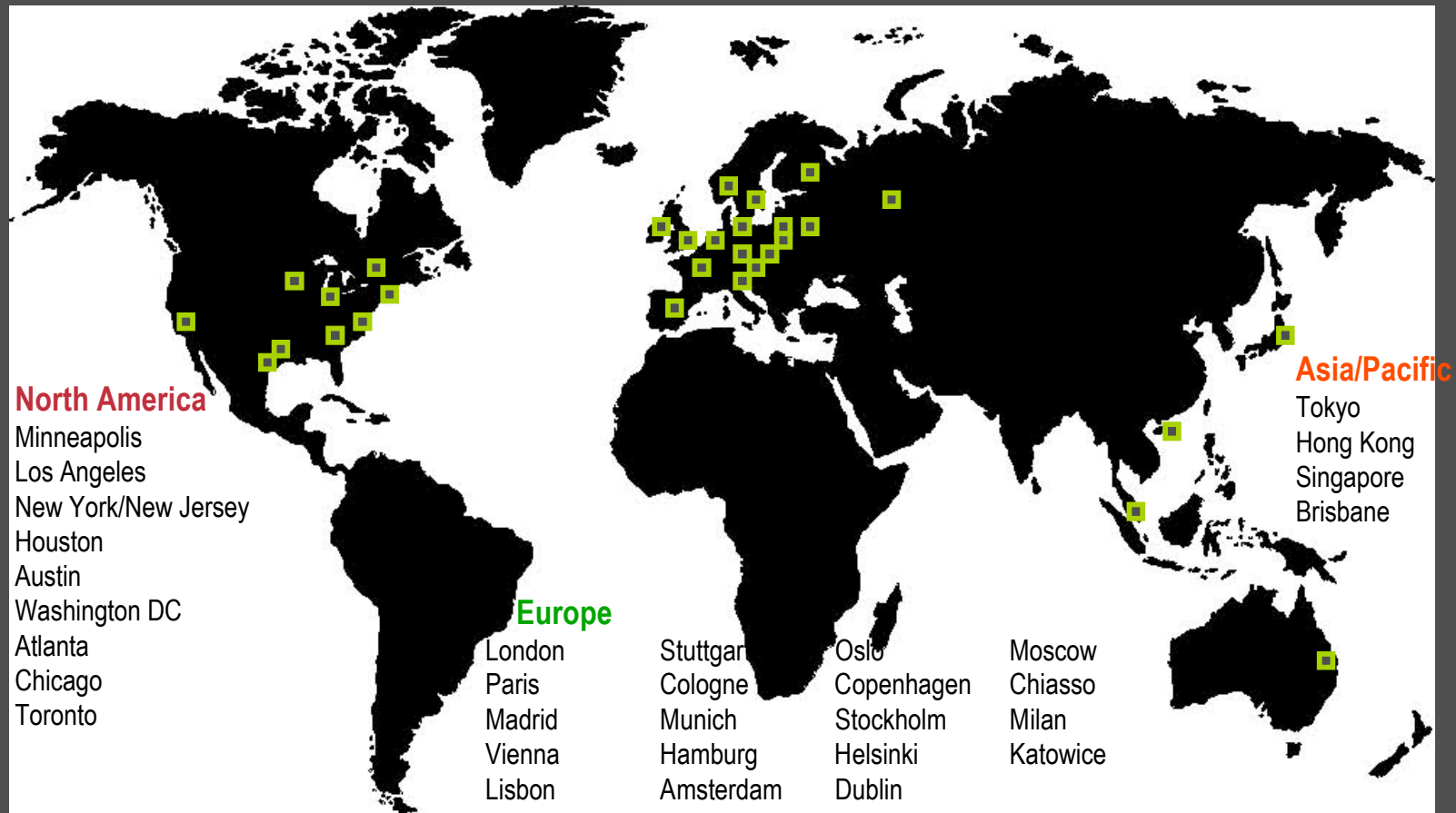


Kroll Ontrack Overview

Kroll Ontrack Inc. is the Technology Services Group of Kroll Inc. and provides solutions to help manage, recover, and discover electronic information

- **Founded in 1985**
- **1,000+ employees**
- **Locations in 20 countries**
- **Acquired by Kroll in 2002**
- **Kroll acquired by MMC in 2004**

Kroll Ontrack Locations



Kroll Ontrack Solution Portfolio

■ Data Recovery Services & Software

- In-Lab
- Remote Data Recovery (RDR)
- On-Site
- Easy Recovery
- Ontrack Eraser Solutions

In 2007 alone, we performed over 60,000 DR jobs and processed over 7 petabytes of data through our worldwide DR operations



■ Legal Technologies Services & Software

- Computer Forensics
- Electronic / Paper Discovery
- Ontrack Firstview
- PowerControls

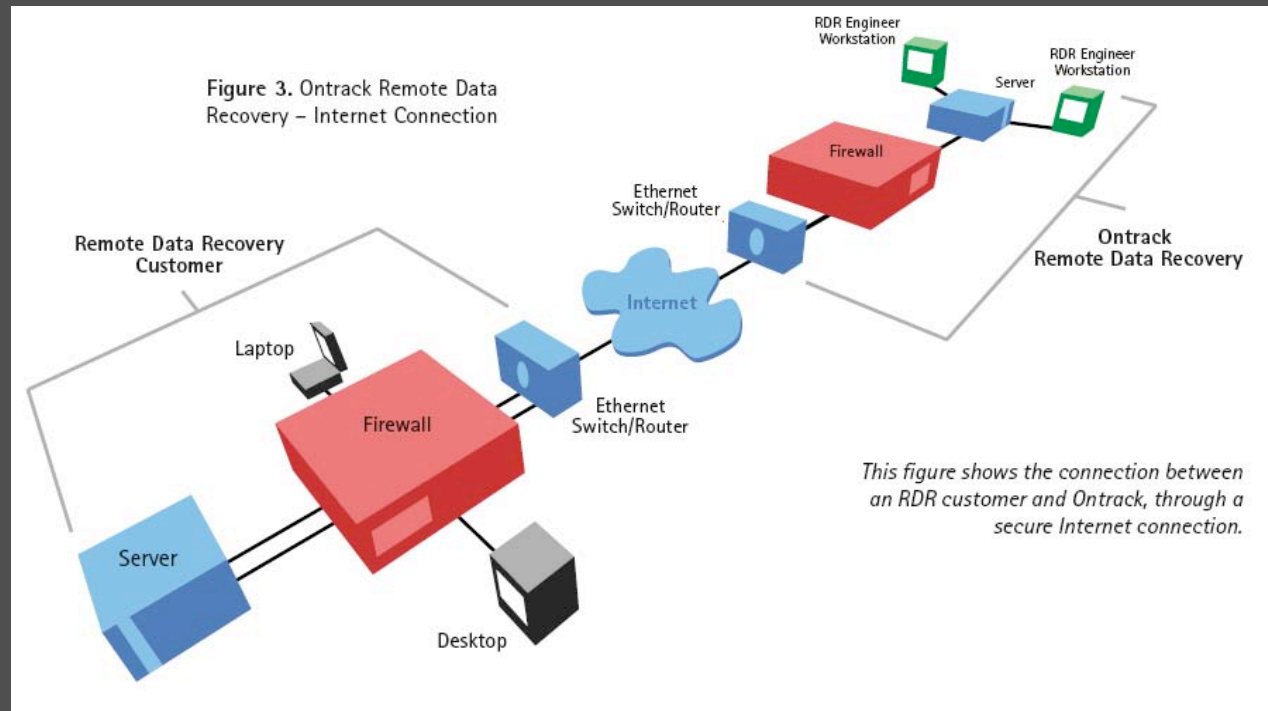
Ontrack Capabilities

Storage Manufacturers		Databases		Operating Systems	
■ Adaptec	■ Network Appliance	■ Microsoft® Exchange	■ Sybase	■ BSD	■ Windows Server™ 2003
■ AMIBus	■ PERC	■ Microsoft® SQL	■ Oracle	■ HP UX	■ Microsoft Windows® 3.x – Vista®
■ Compaq	■ Pinnacle	■ Microsoft® SharePoint	■ DBF	■ IBM® AIX®	■ Apple® Macintosh
■ Dell	■ Promise	■ Visual FoxPro DBF	■ MySQL	■ LINUX®	■ VAX / VMS
■ EMC	■ Raidtec	■ Interbase	■ FileMaker	■ NetWare®	
■ HP	■ Software RAIDs	■ Paradox	■ Lotus Notes	■ Sun™ Solaris™	
■ Logic	■ Storage Dimensions		■ Biz Talk	■ UNIX®	
■ Mylex	■ Sun				
Optical Media		Electronic Media		Magnetic Media	
■ CD-R / CD-RW		■ CompactFlash	■ SmartMedia	■ SCSI, RAID, SAN, NAS, IDE, ATA, SATA	
■ DVD-R / DVD+R		■ Memory Stick	■ USB “Key” Drives	■ All tape media such as DAT, DLT, AIT, LTO	
■ DVD-RAM		■ PC Cards (PCMCIA)	■ xD Media	■ Jaz / Zip, removable media	
■ DVD-RW / DVD+RW		■ SD Media		■ Floppy diskettes	
■ Magneto-Opticals (various formats)					
Tape Media					
■ QIC / 1/4"		■ AIT, AIT2, AIT3		■ StorageTek® 9840, 9940 series	
■ DEC TK		■ 3480/3490/3490E		■ ADR	
■ 8mm		■ Ditto		■ TO (all capacities)	
■ 4mm DAT, DDS, DDS2, DDS3, DDS4		■ SuperDLT		■ VXA	
■ Mini-QIC / Travan		■ Exabyte 8mm 8200/8500/8700, Mammoth, and M2 tape series		■ 9-Track	
■ DLT (all formats)				■ CommVault	
Data Encryption Types					
■ Pointsec		■ SafeGuard Easy		■ PGP	
■ Safeboot		■ PC Guardian		■ Windows EFS	

Remote Data Recovery™

Connect, Recover, Success

- How Does Remote Data Recovery™ work?



- Port80 TCP/UDP used
- Client software initiates connection
- Proprietary Communication Protocol and Packet
- Packets Encrypted using user's IE encryption libraries

Ontrack VeriFile

http://ontrack.com - Ontrack® VeriFile(TM) Online Data Reports - Microsoft Internet Explorer

Ontrack.
VeriFile
Online Data Reports

Help ?

\\Documents and Settings\\JohnDoe\\My Documents\\

NTFS_Partition_1

- Documents and Settings
 - Administrator
 - All Users
 - Default User
 - JohnDoe
 - Application Data
 - Cookies
 - Favorites
 - Local Settings
 - My Documents**
 - JoeDoe's Music
 - JohnDoe's Pictures
 - Recent
 - SendTo
 - Start Menu
 - Templates

Name	Size	Type	Modified Date	Condition
JoeDoe's Music		File Folder	5/4/2005 1:54 PM	
JohnDoe's Pictures		File Folder	5/4/2005 1:54 PM	
10 Commandments.doc	20 KB	doc	11/15/2004 9:10 AM	● Good
411inkjets Injet cartridge order r...	188 KB	doc	1/24/2002 3:38 AM	● Good
411Inkjets.com.fax.doc	43 KB	doc	1/30/2002 1:44 PM	● Good
Animal feeding instructions.doc	22 KB	doc	11/15/2004 9:10 AM	● Good
BRC_agree.doc	15 KB	doc	11/15/2004 9:10 AM	● Good
BRC_Course.doc	18 KB	doc	11/15/2004 9:10 AM	● Good
Chrysler 300M Professional Fax.doc	29 KB	doc	4/30/2001 9:11 AM	● Good
desktop.ini	1 KB	ini	12/16/2004 4:14 PM	● Good
Explorer For Sale bak.doc	19 KB	doc	9/4/2001 7:53 PM	● Good
Explorer for sale on E.doc	237 KB	doc	1/2/2002 10:57 PM	● Good
Explorer for sale on Ebay.bmp	1,875 KB	bmp	1/2/2002 10:57 PM	● Good
Explorer for sale on troys ford sh...	1,875 KB	bmp	1/2/2002 11:29 PM	● Good
Explorer For Sale.doc	19 KB	doc	2/25/2002 8:44 AM	● Good

27 Objects 10.71 MB Sample_NTFS_Partition_1_CustFL.ODR

Total files: 17,522
Total bytes: 2.50 GB

Find Report Filter Options Use Filter Back to Summary

Done Internet



VMware Recovery Scenarios

- Drive, Raid or iSCSI Failure
- VMFS File system corruption
- Deleted files (virtual machine) on VMFS
- VMDK corruption
- Format and Re-install on VMFS volume
- Deleted files inside a virtual machine
- Corruption inside a virtual machine



Thank you!

KROLL ONTRACK®